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On the Probable Motion of the Annular Nebula in Lyra (M 57) and the peculiarities in the Focus for the Planetary Nebulæ and their Nuclei. By E. E. Barnard.

In *Ast. Nach.* 2186, Bd. 92, Professor Hall has given measures of some of the small stars near the annular nebula of *Lyra* (M 57), made with the 26-inch at Washington in 1877 July and August.

I have taken the means of his various measures which are here given. For reference he has used the 12-magnitude star close following the nebula except for the stars f_1 and f_2.

a and *b*	225°·5	93″·90 (2*n*)	Mag. 14
a „ *c*	268·0	115·83 (2*n*)	„ 13·14
a „ *d*	286·9	138·58 (2*n*)	„ 12·13
a „ *e*	292·6	122·90 (2*n*)	„ 12
a „ *f*	313·7	101·79 (2*n*)	„ 13·14
a „ *g*	350·5	77·18 (2*n*)	„ 13
f „ f_1	253·3	3·96 (2*n*)	„ 13·14
f „ f_2	364·8	17·31 (2*n*)	„ 14·15

The different nights' measures, in the main, are very consistent except in the case of *f* and f_2, where the distances differ by one second.

Professor Hall was unable to see any star nearer the nebula than these, and could see no star anywhere within the nebula.

In 1891 Mr. Burnham measured the central star or nucleus with reference to the star *a* with the 36-inch. His measures are very consistent. and are undoubtedly the best that could be made of such an object. He mentions the fact that "all the measures were made under very favourable conditions, and the central star well seen."

On account of their importance I will give his measures in full (they are from *Pub. Lick Obs.*, vol. ii. 1894). The measures refer the star to the nucleus.

	°	″	m	m
1891·326	88·2	61·64	15·5	12·0
·416	87·8	61·44	15·5	13·5
·419	86·5	61·56	15·5	12·0
·518	88·4	62·28	15·0	13·0
·559	88·0	61·56	15·5	11·5
1891·45	87·8	61·69	15·4	12·4

These are the only measures of the nucleus that I know of. It is to be regretted that the admirable example shown by Mr. Burnham in measuring objects of this class is not more fully followed out when the micrometer is available. A mere sketch —no matter how carefully it is made—of the relative position of the nucleus of this object and the surrounding stars has no value whatever for the vital points in question, such as motion, &c. For the first time, therefore, we have the position of the nucleus fixed definitely for reference in future observations.

There is one point lacking, however, and that is, should any relative change occur it could not readily be seen whether it belonged to the nucleus or to *a*, or to both.

The excellent and valuable measures made by Hall in 1877 of the position of *a* with reference to surrounding stars have definitely prepared for this question.

I have been re-measuring some of the planetary nebulæ measured by Mr. Burnham with the 36-inch. The measures have been in very close agreement with his, thus showing no certain motion in the interval of some eight years, except possibly in the present instance.

During 1898 and 1899 I measured the relative position of the nucleus of M 57 and the star *a* with the 40-inch.

When the seeing permits it, the nucleus, in the great telescope, is distinctly seen, and is subject to fairly accurate measurement.

As the question of possible motion of the nebula has come up in the measures, I have measured the position of the nucleus from three other stars, besides repeating the measures of *a*.

These measures have been made with the utmost care, and I believe will fairly represent the relative position of the nucleus at the present time.

The Nucleus of M 57 and the Star a.

1898. July 12	1898·531	88°·98	60″·96
Aug. 8	·605	88·75	60·63
9	·607	88·50	60·87
10	·610	88·74	60·73
29	·662	88·90	60·67
	1898·60	88·77	60·77
1899. June 16	1899·459	89°·12	60″·79
18	·464	88·90	60·70
24	·481	89·67	60·52
July 1	·500	88·74	60·88
2	·503	89·27	60·74
	1899·48	89·14	60·73

The Nucleus and the Star b.

1899. July 29	1899·577	185°·46	65″·15
31	·582	185·40	65·15
Aug. 1	·585	185·25	65·07
	1899·58	185·37	65·12

The Nucleus and the Star c.

1899. July 8	1899·519	268°·27	54″·91
10	·525	266·72	55·22
16	·541	267·78	54·85
	1899·53	267·59	54·99

The Nucleus and the Star e.

1899. June 24	1899·481	312°·55	71″·14
July 1	·500	312·08	70·91
2	·503	312·50	71·14
	1899·49	312·38	71·06

It will be seen that my measures of the nucleus and *a* differ from Mr. Burnham's by about 1° in angle and 1″ in distance. While this is a small quantity for two different observers and telescopes dealing with a difficult object of this kind, yet it is worthy of consideration when the power of the instruments is considered, and when the two observers are as consistent as they always are in measurements like these. I am therefore under the impression that this apparent relative change may be a real

one, and the question comes up whether it is due to change in the star *a* or in the nucleus.

To test the stability of *a* I have repeated Professor Hall's measures of 1877, and have added three other stars to the list which have not previously been measured.

Of these stars the following are my estimates of magnitude with the 40-inch :—

	m		m
a	12·2 (3)	f_1	13·9 (2)
b	13·8 (2)	f_2	14·5 (2)
c	14·0 (3)	*g*	13·7 (2)
d	13·5 (3)	*h*	12·8 (3)
e	13·2 (3)	*k*	15·7 (4)
f	13·7 (3)	*p*	16·5 (2)*

* The position in reference to the nebula makes it difficult to decide on the magnitude of this star *p*. It is perhaps as bright as the $15\frac{1}{2}$ magnitude.

Following are the measures :—

a and b.

1899.		°	″
July 1	1899·500	225·50	93·54
2	·503	226·02	93·88
8	·519	225·77	93·65
	1899·51	225·76	93·69

a and c.

1899.		°	″
June 26	1899·486	268·75	115·73
July 1	·500	268·81	115·59
8	·519	268·77	115·83
	1899·50	268·78	115·72

a and d.

1899.		°	″
June 24	1899·481	286·59	*″
26	·486	287·17	137·59
July 2	·503	287·12	137·77
8	·519	286·97	137·95
	1899·50	286·96	137·77

* Seeing too poor for distance.

a and e.

1899.		°	″
June 17	1899·462	292·91	122·27
24	·481	292·72	122·30
	1899·47	292·81	122·28

a and g.

1899.		°	″
June 17	1899·462	350·91	75·90*
18	·465	350·60	76·34*
July 10	·525	350·75	76·78
Aug. 6	·600	350·85	76·00
	1899·51	350·78	76·25

* Single distance; faint and difficult.

a and f (the following and brightest of two).

1899.		°	″
June 26	1899·486	315·47	100·07
July 8	·519	315·32	100·11
	1899·50	315·39	100·09

f and a Star close preceding = f_1.

1899.		°	″
July 8	1899·519	261·10	5·11
9	·522	264·70	4·97
10	·525	263·05	4·62
	1899·53	262·95	4·90

f and a Star north = f_2.

1899.		°	″
July 8	1899·519	2·93	17·88
10	·525	3·92	17·89
	1899·52	3·42	17·88

Following are the three additional stars not previously observed :—

a and h.

1899.		°	″
June 16	1899·459	148·25	70·70
17	·462	148·23	70·36*
24	·481	147·94	70·80
	1899·47	148·14	70·62

* Clock drifting badly.

a and h.

1899.		°	″
July 31	1899·582	195·70	85·56
Aug. 1	·585	195·85	83·57*
5	·596	196·30	84·91
	·599	195·63	85·31
	·604	195·82	85·25
	1899·59	195·86	85·26

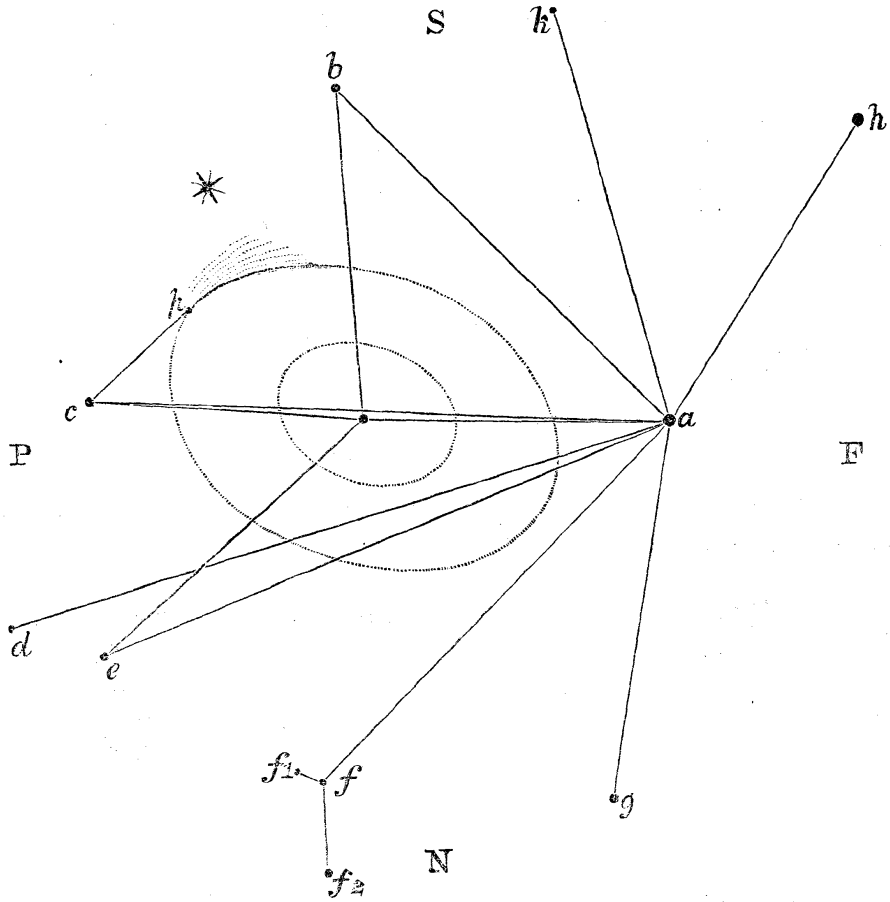
* Reject the distance.

c and p (in preceding edge of Nebula).

1899.		°	″
July 8	1899·519	133·30	27·08
10	·525	133·38	27·46
	1899·52	133·34	27·27

This star *p* is *exactly* on the north preceding edge of the nebula. The outline of the nebula would cut *exactly* through the star.

There is a 17th magnitude star—at the limit of vision for the 40-inch, and hence a good subject for photography—in 218° ± 60″ ± referred to the nucleus. This star was too faint to measure accurately, and I have taken its place from a sketch. On the diagram its place is marked with a ×.



Micrometrical Measures of M 57 and neighbouring stars.

The star *k* for some reason is very difficult to measure—more so than its magnitude would warrant. It has a dull appearance, and does not seem so well defined as stars of similar magnitude near. It looks as if it might be either a very small nebula or nebulous star.

In comparing these measures with Hall's made twenty-two

years ago there appears to be some change in some of the stars, but there is no very decided motion shown in the position of *a*.

The star *f* seems decidedly to be in motion when compared with f_1 and *a*. The position angle of f_1 has increased about 10°, and the distance about 1″, while the distance *a f* seems to have diminished over $1\frac{1}{2}$″.

If we reduce the two sets of measures of *a* and *f* to $\Delta\alpha$ and $\Delta\delta$, we get :—

Hall	...	...	$\Delta\alpha$	73″·59	$\Delta\delta$	70″·32
Barnard	...	...		70·29		71·25
				3·30		0·93

The same for *f* and f_1 gives :—

Hall	...	...	3″·79	1″·14
Barnard	...	...	4·86	0·60
			1·07	0·54

while for *f* and f_2 the discordances are within the possible errors of measurement.

There seems to be possibly some motion in *d* also ; but it is uncertain. Some of the apparent change in *f* may be due to change in *a*, which might also account for the lessening of the distance *a d*. It seems to be difficult just now to definitely locate the motion, but it appears certain that motion is shown to exist in one or more of the stars.

The measures of *a* and *c*, however, show that the discrepancy in Mr. Burnham's measures of the nucleus and mine cannot be due to any motion in *a*, for it would also affect the distance *a c*, which does not seem to have sensibly changed in the past twenty-two years.

If the apparent motion shown by Mr. Burnham's measures and mine is real it next becomes a question whether the motion can be said to be in the nebula—that is, is the central star a real nucleus or an accidental projection ? Everything points to its being a part of the nebula—that is, the nucleus. It is shown by photography to be highly actinic, though visually a very faint body, so that the relative photographic quality of its light is greater than that of other faint stars near.* It is almost certain, then, that if motion is found to exist in this central star it is a motion of the nebula itself.

I would suggest that the question of motion in this nebula is one singularly suited for the photographic plate to decide, because of the high actinic power of the nucleus. I should be very glad to see measures made of any existing photographs of this object, and I hope that the present paper will call attention to the

* I find that Dr. Scheiner (*Ast. Nach.* 3086), and Prof. Keeler (*Ast. Nach.* 3111), have shown that the central star M 57 must in reality be the nucleus of the nebula.

importance of securing accurate photographic data for the future investigation of the nebula and its surroundings.

The question of motion of the star *f* is an important one on account of its faintness.

So far as the visual work is concerned, the nucleus is now thoroughly tied up with the stars *a*, *b*, *c*, and *e*, and observations five or six years hence ought to show conclusively if the supposed motion is real. If there are any measurable photographs made six or eight years ago, they would be rather conclusive compared with others made now.

All the measures with the 40-inch have been reduced with a screw value of $9''.677$. A final reduction of all the determinations running over some three years will slightly reduce this value, but not to materially affect the present measures.

In *A.N.* 3200 I have given an account (with sketch) of the discovery with the 36-inch, on 1893 October 2, of a rather conspicuous nebula, only 4′ from the centre of the ring nebula. I have measured this object with the 40-inch, in which it is decidedly conspicuous.

*Nucleus of M 57 and Nebula.**

1899 July 16	1899·541	303°·9	244″·47
17	·544	303·8	244·22
	1899·54	303·8	244·34

The measures in 1893 (two nights) gave :—

Nucleus and Nebula.

1893·76	302°·8	243″·68

During 1893 and 1894 I secured a series of measures of the dimensions of M 57 and the position angle of the major axis. These were published in *Ast. Nach.* 3354. I will here repeat the mean results of these measures for completeness in the present paper.

Position Angle of the Major Axis.

1893·95 ... ... 65°·43 (9 nights)

Outer Major Diameter.

1894·44 ... ... 80″·89 (5 nights)

Inner Major Diameter.

1893·87 ... ... 36″·52 (5 nights)

Outer Minor Diameter.

1894·12 ... ... 58″·81 (6 nights)

* In an article in the October *Astrophysical Journal* Professor Keeler says that his photographs of the annular nebula show this small nebula to be a left-handed spiral.

Inner Minor Diameter.

1893·87 ... ... 29″·36 (5 nights)

All the measures in this paper depend on double distances. From four to five settings for the position angles and three to four settings on each side of the fixed wire for the distances were made.

The nebula is a beautiful object in the great telescope; though the ring appears to be unequally bright in places, but little detail can be made out on it with certainty. There is a faint brushing out of the light from the south preceding edge of the ring. Under the best conditions the interior of the ring has appeared of unequal brightness. The light of the ring itself, however, blinds one's eye to the details on the interior, so that it is not possible to speak with certainty of the form of these details.

In *Comptes Rendus*, No. 5, for 1899 July 31 is a paper by MM. Bourget, Montangerand, and Baillaud calling attention to important changes which they find to have occurred in this nebula in the past ten years.

According to these observers the central star or nucleus has increased greatly in brightness of late years.

These gentlemen, observing the nucleus on 1899 July 8 with the great reflector of the Toulouse Observatory, of $0^m{\cdot}83$ (33 inches) aperture, found it an easy object. From this observation, and from photographs made in 1890 and 1899, they concluded great changes had taken place, both in the form of the nebula and in the brightness of the central star.

I have been familiar with this object for upwards of ten years, as it has appeared in the 36-inch at the Lick Observatory and in the 40-inch here. In 1893 and 1894 I made a special study of the nebula with the 36-inch, and measured all its dimensions on a number of nights, and specially noted the appearance of the central star.

So far as visual observations go, I am unable to verify the striking changes indicated by the Toulouse observations. Indeed, on the very night that those observations were made—1899 July 8—I measured the nucleus with the 40-inch, and saw nothing different from what I have seen for the past ten years. On that night I noted the nucleus as about $15\frac{1}{2}$ or 16^m from a direct estimate, and from comparison with a star outside the ring. Mr. Burnham's estimate in 1891 made it 15·4 magnitude.

The nucleus of this object is quite like that of the *Andromeda* nebula (M 31) in the uncertainty and deception in fixing any change that might occur in its brightness. The fact that the nucleus is seen on a nebulous background makes steadiness of the atmosphere a most important factor in its distinctness—far more so than in the case of an ordinary star in the open sky. When the seeing is exceptionally good, the nucleus appears with a distinctness strikingly in contrast with its ordinary condition,

so much so that one has to guard against deception in supposing a real change of light. So much do the atmospheric conditions enter into this question of change in the nucleus of a nebula that the frequent observations of variability in these objects might be properly translated into "fine seeing," "good seeing," "poor seeing," and " bad seeing " in the decreasing order of reported brightness of the object.

The observers at Toulouse also speak of their photographs having likewise proved that the central star had increased greatly in brightness. They do not say, however, that the nucleus is brighter than stars on the same plate which it had equalled in 1890. Such might be considered a test of actual change, though this in itself is also subject for criticism from the very causes mentioned above, though not to the same extent. The fact, however, that a photograph of to-day shows the star quicker than one nine or ten years ago, might be accounted for by an increase of sensitiveness of the plate alone.

Since writing the main portion of this paper I have seen some very fine photographs of M 57 taken by Professor Keeler with the 37-inch Crossley reflector of the Lick Observatory. These beautiful photographs show the very faint star I have mentioned as being essentially at the limit of the 40-inch, and also several stars that are apparently fainter on the photographs. The brushing out of the nebulosity from the south preceding edge of the ring is shown, and a similar appearance from the north following edge. These photographs also show a second star in the ring north preceding the central star. The star p is also shown. I have never been sure of seeing the second star in the ring, but have thought at times that I could see it faintly. This star is difficult visually, not only on account of actual faintness, but also from the fact that it is near the inner edge of the bright ring which blinds one to its feeble light. It was seen at the Lick Observatory, and described in a paper on the nebula by Professors Holden and Schaeberle in *M.N.* vol. xlviii. p. 383.

In a paper in the *Astrophysical Journal* for 1899 October Professor Keeler seems to infer that the star p is not a real star, but a condensation in the nebula. This seems hardly probable, for it is exactly on the extreme edge of the nebula visually, and I have been struck with its perfectly stellar appearance when measuring it, and have so recorded it. I think it must be but an ordinary star, and that its close proximity to the nebula is quite accidental.

In a drawing of M 57, made with the 4-foot reflector, issued in a circular dated " Bradstones, Sandfield Park, near Liverpool, 1860 November 19," Lassell shows the central star (not, however, exactly in its true position), and refers to it as being near the limit of vision of his telescope.

Peculiarities in the Focus for the Planetary Nebulæ.

It is a well-known fact that the planetary nebulæ come to a focus outside the focus for an ordinary star. This, of course, is due to peculiarities in their spectra.

In examining the different planetary nebulæ, I have made some experiments in this line with the 40-inch, which may be of general interest.

With a magnifying power of 1300 diameters in these observations, the nebula was brought to the best focus, and a scale of inches on the focussing tube read. This would be repeated for the nucleus and also for an ordinary star. The result so far has been tabulated, and the quantities given are fractions of an inch. A plus quantity means that the first object comes to a focus further from the object glass than for the second. It is probable, by this means, we may be able to determine the wave length of the light of the nuclei of these nebulæ, which are too faint to observe with the spectroscope.

This table is preliminary, and as the subject will be carried out for all the planetary nebulæ, a more complete and accurate table will be published later. It is of sufficient interest, however, to warrant its publication here in an incomplete form.

Table of Focus for the Planetary Nebulæ.

N.G.C.	α 1860·0. h m s	δ 1860·0 ° ′	Neb.—Nucl. in.	Neb.—Star. in.	Nucl.—Star. in.
1535	4 7 44	−13 6	+0·22	+0·27	+0·05
2392	7 20 53	+21 12	+0·26	+0·29	+0·03
6543	17 58 36	+66 38	+0·18	+0·23	+0·05
6720 (M 57)	18 48 23	+32 51	+0·20	+0·30	+0·10
6826	19 41 2	+50 11	+0·22	+0·21	−0·01
7009	20 56 33	−11 55	+0·19	+0·23	+0·04
7662	23 19 11	+41 45	+0·06	+0·20	+0·14
			+0·19	+0·25	+0·06

These are in each case the means of five or more settings for focus.

The focus for Hind's celebrated crimson star is 0·06 in. outside of that for a white star nearly of same magnitude.

It will be seen from this tabulation that the planetary nebulæ so far observed give a focus for the nebula itself—about 0·19 inch farther out than its nucleus and about 0·25 inch farther out than for a fixed star. It is seen also that the nucleus comes to a focus nearer the fixed star than for the nebula and a little farther out than for the star.

The average doubtless does not mean as much as might be supposed. There seem to be individual cases which markedly differ from the others. For instance, 2392 is conspicuously

distinct from the others in the large increase of focus for its nebulosity, while the central star focus closely agrees with the average difference of nucleus-star. No. 6826 seems abnormal in this last respect. The central star seems to come out about the same for its comparison star. The minus sign is doubtless accidental. There are no details in this nebula, so that the focus for the nebula itself is rather difficult, though the settings are accordant.

No. 2392 is one of the most remarkable of the planetary nebula. Singularly enough, Dreyer in his careful New General Catalogue does not indicate its planetary character, nor does he indicate anything memorable about it by the usual "! !" His description is

B, S, R, *9M, *8 nf 100″.

So far as its appearance in a great telescope is concerned, it should have the usual planetary nebula sign O, with a string of exclamation points (!) running across the page.

It is a magnificent and beautiful object, a bright star of the ninth magnitude in—not exactly central—a brightish ring which is oval in form and almost incomplete in its southern part. This ring, which is well defined inside and out, is surrounded by a vacuity, and this in turn by an almost circular broad ring of light less intense than the inner ring, and with a distinct break in it north preceding. This ring breaks up into a clouded or unequal surface, and is very irregular on its inner edge but fairly uniformly circular on its outside edge. The inner ring is filled with a nebulous light which has a black spot in it, s p, the nucleus. I have found another excessively difficult star inside the inner ring south of the bright star: this minute star comes to a focus with the nebula and not with the central star. It is therefore doubtless a minute condensation of the nebula not so far advanced in stellar condition as the bright star.

I have measured all the dimensions of this nebula and am making a drawing of it.

No. 1535 is an exact duplicate of 2392, except that its central star is not so bright, and there is lacking the vacuity outside the inner ring, which is also oval in form, with a nebulous interior. Some of the other planetary nebulæ are very wonderful objects, and I am making a special study of them and hope to secure drawings and measures of the more prominent ones.

Several other of the planetary nebulæ now visible were examined for focus, among them Σ 5 (No. 6210) and Σ 6 (No. 6572), nothing could be made out of these except that they were almost identical in form and size and general appearance. The planetary nebula No. 6781 (1860·0 19^h 11^m 38^s, +6° 17′) is annular, the centre being dark. The star measured by Mr. Burnham (*Pub. L. O.*, vol. ii. p. 165), which he speaks of as being north of the middle, is evidently not the nucleus—it looks

more like a star. There is, however, a much fainter star at the middle which looks like the true nucleus, and is of the $16\frac{1}{2}$ mag.

It is intended ultimately to compare all the comparison stars used for focus with some star whose spectrum is definitely known.

Yerkes Observatory, Williams Bay, Wisconsin:
1899 *October.*

Note.—While visiting Potsdam on 1900 February 2, I was shown an excellent photograph of M 57, taken by Dr. Scheiner with the 13-inch photographic refractor, 1894 October 29, at sidereal $21^h\ 20^m$, with an exposure of two hours. This photograph quite clearly shows the nucleus of the nebula; and, upon learning of the discrepancy in the visual measures, Dr. Scheiner very kindly measured the plate for me, and I am happy to be able through his courtesy to give here the results which, though they do not confirm any change in the nebula, are very important as a contribution to the history of the subject.

Through the further courtesy of Dr. Scheiner I was permitted to measure the plate also; but, as I am wholly inexperienced in the measurement of photographs, my measures should have very little weight compared with his, though I shall give the results of the two sets of measures, as supplied me by Dr. Scheiner.

The measures are in rectangular co-ordinates, the distances and position angles having been deduced from them by Dr. Scheiner. "Corrections for refraction and aberration have not been applied. The uncertainty by the reduction to arc may be $\pm 0''.05$, and by the error of the parallel $\pm 0°.15$."

Following are the measures of this photograph referred to Star a :—

	S	B	Mean.
	"	"	
Co-ord. in A.R.	60·84	60·54	
Co-ord. in Decl.	0·99	1·32	
Distance (computed)... ...	60·85	60·56	60″·71
Pos. Ang. (computed) ...	89° 4′	88° 45′	88° 55′

The mean results, as shown, are position angle, 88°·92; distance, 60″·71.

It is still important that the nebula be carefully measured with some of our powerful telescopes six or eight years hence.

I wish to express my great obligations to Dr. Scheiner for his kindness.

London:
1900 *February* 10.

The Exterior Nebulosities of the Pleiades, with a Drawing from the different Photographs; and on the appearance of the involved Nebulosities of the Cluster with the 40-inch Refractor. By E. E. Barnard.

In *Astronomische Nachrichten* 3253, Bd. 136, I have given an account, with a rough chart, of what I have called the exterior nebulosities of the *Pleiades*, and which were shown on photographs made with the Willard 6-inch portrait lens in 1893 December. In that paper I have stated: "For many years, during my comet-seeking, I have known of a vast and extensive, but very diffused, nebulosity north of the *Pleiades*. Other masses of this diffused matter make their presence known by a general dulling of the field when sweeping in the neighbourhood of the cluster. . . . It has been my hope during the past two or three years to sometime be able to secure a photographic impression of these vague nebulosities that I had seen in the telescope. It was evident this would require a long exposure. The mounting of our Willard lens does not permit an exposure to be carried beyond the meridian; to get sufficient time would therefore require more than one night. This past winter I have been able, by carefully inclosing the camera box in thick black cloth and by taking other precautions, to extend the exposure through two nights with success. Previous to this I gave an exposure on the *Pleiades* of four hours, which showed all the well-known nebulosities and gave faint suggestions of more distant wisps of nebulæ."

Circumstances prevented my securing a long-exposure photograph of the *Pleiades* in the winter of 1894, and since then I have not had an instrument for the purpose.

As in the case of the great nebula of ρ *Ophiuchi*, these nebulosities were known to me visually for many years before they were photographed. Indeed, there are other such nebulous regions elsewhere which I have seen in comet seeking, and I hope soon to be able to secure photographs of them, as in the case of the *Pleiades* and of ρ *Ophiuchi*. Some of these yet unphotographed nebulosities are, I believe, fully as remarkable as those just mentioned.

In the winter of 1898 Dr. H. C. Wilson, of Northfield, Minnesota, fully verified the exterior nebulosities of the *Pleiades*, and secured good photographs of them. In an endeavour to verify them he had secured traces as far back as 1894, with an exposure of $11^h\ 15^m$; but the photographs of 1898, with $5^h\ 35^m$ exposure, showed them distinctly. Dr. Wilson has given an account of these photographs, with reproductions, in *Popular Astronomy* for 1899 February.

In the summer of 1898, while visiting Harvard College Observatory, I was shown, among many other interesting photographs, one of the *Pleiades* made at Arequipa, Peru, on 1897 October 29, by Professor Bailey with the 8-inch Bache telescope.